ENVIRONMENTAL PRODUCT DECLARATION

as per *ISO 14025* and *EN 15804+A2*

Owner of the Declaration	REHAU Industries SE & Co. KG
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-REH-20250242-IBI1-EN
Issue date	07.05.2025
Valid to	06.05.2030

RAUTITAN stabil

REHAU Industries SE & Co. KG

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1. General Information

REHAU Industries SE & Co. KG

Programme holder

IBU – Institut Bauen und Umwelt e.V.
Hegelplatz 1
10117 Berlin
Germany

Declaration number

EPD-REH-20250242-IBI1-EN

This declaration is based on the product category rules:

Plastic pipe systems for hot and cold water installation in the building, 01.08.2021
(PCR checked and approved by the SVR)

Issue date

07.05.2025

Valid to

06.05.2030

Dipl.-Ing. Hans Peters
(Chairman of Institut Bauen und Umwelt e.V.)

Florian Pronold
(Managing Director Institut Bauen und Umwelt e.V.)

RAUTITAN stabil

Owner of the declaration

REHAU Industries SE & Co. KG
Helmut Wagner Straße 1
95111 Rehau
Germany

Declared product / declared unit

1 kg "RAUTITAN stabil" pipe

Scope:

The EPD applies to 'RAUTITAN stabil' pipe with the pipe sizes:

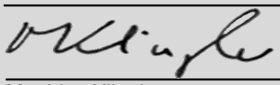
16.2 x 2.6 mm
20.0 x 2.9 mm
25.0 x 3.7 mm
32.0 x 4.7 mm
40.0 x 6.0 mm
50.0 x 4.5 mm
63.0 x 6.0 mm

The pipes are produced at the REHAU Industries SE & Co. KG plant in Triptis. In 2022, 0.2% by weight of annual production was manufactured in an external plant in Germany.
This is a representative EPD.
The owner of the declaration shall be liable for the underlying information and evidence; the IBU shall not be liable with respect to manufacturer information, life cycle assessment data and evidences.

The EPD was created according to the specifications of EN 15804+A2. In the following, the standard will be simplified as *EN 15804*.

Verification

The standard EN 15804 serves as the core PCR
Independent verification of the declaration and data according to ISO 14025:2011
☐ internally ☒ externally



Matthias Klingler,
(Independent verifier)

2. Product

2.1 Product description/Product definition

The pipes for hot and cold water installations in the building covered by the study are five-layer aluminium-plastic composite pipes. The aluminium-plastic composite pipes consist of an inner pipe made of crosslinked polyethylene and a subsequent bonding layer. The third layer consists of aluminium. This is followed by a second bonding agent layer and a coloured outer layer of PERT. The pipe can be used universally for drinking water and heating installations. The trade name is 'RAUTITAN stabil'. The product is not subject to any EU harmonisation legislation.
The respective national regulations at the place of use apply to the use of the product.
The pipes are manufactured in Germany. The products are used worldwide, with a focus on Europe.

2.2 Application

The pipes in the 'RAUTITAN stabil' product group can be used universally for drinking water and heating installations in building construction in accordance with EN ISO 21003. The pipes are also oxygen-tight in accordance with DIN 4726.

2.3 Technical Data

The values given in the following table apply to the 'RAUTITAN stabil' product in all pipe sizes.

Structural data

Name	Value	Unit
Permissible operating pressure PN of the pipe system	10	bar
Material 1a: inner layer for 16.2 x 2.6 mm - 40.0 x 6.0 mm	PE-Xa	
Material 1b: inner layer for 50.0 x 4.5 mm - 63.0 x 6.0 mm	PE-Xc	
Material 2: Haftvermittler	PE-based	
Material 3: Aluminium	aluminium	
Material 4: Außenschicht	PE-RT	
Average density of the material according to EN ISO 11831, or 2; PE--Xa	0,93-0,97	g/cm^3
Average density of the material according to EN ISO 11831, or 2; PE--Xc	0,93-0,97	g/cm^3
Average density of the material according to EN ISO 11831, or 2; PE-based bonding agent	0,91-0,93	g/cm^3
Average density of the material according to EN ISO 11831, or 2; aluminium	2,70	g/cm^3
Average density of the material according to EN ISO 11831, or 2; PE-RT	0,94	g/cm^3

Performance values of the product in relation to its characteristics according to the relevant technical specification (EN ISO 21003).

2.4 Delivery status

Bundles:

- 16.2 x 2.6 mm: 100 m
- 20.0 x 2.9 mm: 100 m
- 25.0 x 3.7 mm: 50 m
- 32.0 x 4.7 mm: 25 m

Bars:

- 16.2 x 2.6 mm: 5 m
- 20.0 x 2.9 mm: 5 m
- 25.0 x 3.7 mm: 5 m
- 32.0 x 4.7 mm: 5 m
- 40.0 x 6.0 mm: 5 m
- 50.0 x 4.5 mm: 5 m
- 63.0 x 6.0 mm: 5 m

2.5 Base materials/Ancillary materials

Name	Value	Unit
PE-Xa / PE-Xc	57-70	%
Bonding agent	2-8	%
Aluminium	19-32	%
PE-RT	4-9	%

1) The product contains **no** substances on the *ECHA list* according to the *REACH Regulation (EC) No. 1907/2006* of Substances of Very High Concern (SVHC) (14.06.2023) above 0.1% by weight.

2) The product contains **no** other CMR substances (carcinogenic, mutagenic and toxic for reproduction) of category 1A or 1B, which are not on the candidate list according to *REACH Regulation (EC) No. 1907/2006* above 0.1% by weight in at least one sub-product.

3) **No** biocidal products have been added to this construction product and it has **not** been treated with biocidal products (it is therefore **not** a treated product within the meaning of the *Biocidal Products Regulation (EU) No. 528/2012)*.

In the case of pipe sizes 16.2 x 2.6 mm – 40.0 x 6.0 mm, an organic peroxide is used to crosslink the polyethylene. This is consumed during the cross-linking reaction.

The product contains an antioxidant from the group of sterically hindered phenols.

2.6 Manufacture

In the case of pipe sizes 16.2 x 2.6 mm – 40.0 x 6.0 mm, the pipes are produced by REHAU Industries SE & Co. KG in a factory in Germany. In the pipe manufacturing process, the PE is peroxide-crosslinked under high pressure to form PEXa and then coated with a bonding agent, aluminium, bonding agent, and outer layer.

A share of 0.2% by weight of annual production (pipe sizes 50.0 x 4.5 mm – 63.0 x 6.0 mm) is produced in an external plant in Germany. In the pipe manufacturing process, the PE is radiation-crosslinked and then coated with a bonding agent, aluminium, bonding agent, and outer layer.

2.7 Environment and health during manufacturing

All legal regulations with regard to exhaust air, waste water and waste as well as noise emissions are complied with or undercut. The health of the employees is not jeopardised during production.

2.8 Product processing/Installation

To connect the RAUTITAN stabil pipes, use REHAU compression sleeves, fittings and compression fittings from the RAUTITAN universal system. For further important information on installation and pipe connections, please refer to the Technical Information on the RAUTITAN universal system (893621), available at https://www.rehau.com/qr/a0c6d6db5b.

2.9 Packaging

The pipes are produced as bundles or bars. The pipe openings are sealed with PE plugs.

The pipe bundles are wrapped in PP tape and packed in

cardboard. The cartons are secured to a EURO pallet with PE foil.

Disposable product packaging can be recycled via local recycling collections.

2.10 Condition of use

The pipes are very durable and long-lasting. No special features of the material composition for the period of use (material changes during use, environmentally-relevant inherent material properties) are known.

2.11 Environment and health during use

No negative effects on the environment and health are to be expected during use.

2.12 Reference service life

No reference service life is specified. The pipes are designed for a service life of 50 years in accordance with *EN ISO 21003*.

2.13 Extraordinary effects

Fire

Flammability: Building material class E (according to *EN 13501-1*)
Due to the installation situation, burning droplets and flue gas development are not relevant.

Water

No consequences for the environment in the event of unforeseen exposure to water.

Mechanical destruction

No consequences for the environment in the event of unforeseen mechanical destruction.

2.14 Re-use phase

At the end of the utilisation phase, the pipes can be thermally recycled (recovery of thermal and electrical energy).

Various components of the pipe can be recycled. To do this, the pipe is crushed and the aluminium is separated from the polymer components. The aluminium fraction can then be returned to the aluminium cycle.
As the polymer fraction consists largely of thermoset cross-linked polyethylene (PEX), mechanical recycling is not possible. However, granulated polymer material can be used as a filler in other products.

The technology of chemical recycling of PEX is currently being advanced in close cooperation with the plastics industry. It is therefore to be expected that pipes installed today can be returned to a closed material cycle after their utilisation phase (50 years).

Thermal utilisation (scenario 0) and mechanical recycling with reuse (scenario 1) are discussed in section 3.2.

2.15 Disposal

At the end of its life cycle, RAUTITAN stabil can be sent for thermal utilisation. Due to the high calorific value of polyethylene, the bound energy can be used for energy recovery.

Depending on local conditions, landfilling may take place under certain circumstances.

The possibility of landfilling (scenario 2) is discussed in section 3.2.

The waste code of the pipe according to the *European Waste Catalogue* is 07 02 13.

2.16 Further information

Further information can be found on the product page and in the catalogue at:
www.rehau.de/rautitan

3. LCA: Calculation rules

3.1 Declared Unit

The declared unit is defined as '1 kg of pipe'. This corresponds to 0.99 kg of installed pipe (see scenario information on module A5 in section 4).

A representative product of the 'RAUTITAN stabil' pipe was analysed. It represents a worst-case scenario for 99.7% by weight of all products manufactured in 2022 and covers all product variants (listed in 2.4 'Delivery status'). The mass reference differs depending on the pipe size.

Declared unit

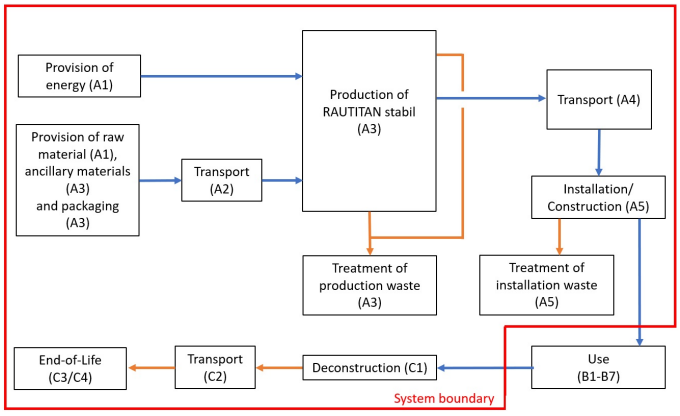
Name	Value	Unit
Declared unit	1	kg
Gross density	1415	kg/m^3
Mass reference 16.2 x 2.6 mm	0,135	kg/running metre
Mass reference 20.0 x 2.9 mm	0,191	kg/running metre
Mass reference 25.0 x 3.7 mm	0,302	kg/running metre
Mass reference 32.0 x 4.7 mm	0,474	kg/running metre
Mass reference 40.0 x 6.0 mm	0,747	kg/running metre
Mass reference 50.0 x 4.5 mm	0,778	kg/running metre
Mass reference 63.0 x 6.0 mm	1,20	kg/running metre

3.2 System boundary

Consideration of the entire product life cycle if the utilisation phase is not taken into account, see figure.

Type of EPD: cradle to factory gate with options (modules A4, A5, C and D).

The following flow diagram shows the system limits when balancing 'RAUTITAN stabil'.



The following is a detailed list of the life cycle stages and process modules taken into account for the production of the pipe:

A1-A3 Production phase:

- External production of raw materials, operating materials and ancillary materials, including transport to the plant
- External production of packaging materials for raw materials, including transport for recycling with subsequent utilisation
- Return transport of reusable packaging for raw materials
- External production of packaging materials for the end product, including transport to the plant
- Energy supply for production
- Production of the pipes by extrusion
- In the case of pipe sizes 50.0 x 4.5 mm - 63.0 x 6.0 mm, external radiation crosslinking
- External processing or thermal utilisation of production waste incl. transport

A4 and A5 construction phase:

- Transport of the pipe to the construction site
- Transport of the pipe packaging for recycling with subsequent recycling
- Energy supply for the installation (e.g. electrical tools)
- Production of ancillary materials (cement)
- Transport and utilisation of assembly waste
- Flushing the installed pipe with tap water

C1-C4 Disposal:
Three 100% disposal scenarios are assumed:

- EoL scenario 0 (thermal utilisation): dismantling the pipe, including transport to the recycling site with energy recovery (modules C1, C2, C3, C4 and D)
- EoL scenario 1 (recycling): dismantling the pipe, including transport to the recycling site with material recycling, i.e. washing, drying, shredding, sorting and grinding (modules C1, C2/1, C3/1, C4/1 and D/1)
- EoL scenario 2 (landfill): dismantling the pipe, including transport to the disposal site Disposal takes place at a local landfill (modules C1, C2/2, C3/2, C4/2 and D/2).

D Reuse, recovery and/or recycling potentials:
Reuse, recovery and/or recycling potentials are present in the disposal scenarios, as here the pipes are sent for energy or material recovery, from which energy or secondary materials are recovered that can be used outside the system boundary. In EoL scenarios 0 and 1, on the other hand, there are effects from the recovery of energy from the incineration of waste. In EoL scenario 1, advantages from the subsequent utilisation of secondary material are taken into account.

Energy recovered from the incineration of packaging and assembly waste in module A5 is taken into account in each of the scenarios.

3.3 Estimates and assumptions

REHAU Industries SE & Co. KG provides the primary data on the composition of the pipe as well as on energy utilisation and the transport routes and packaging of the raw materials.

No underlying datasets were available for the production of the antioxidant and the peroxide, so their production was approximated with the production of the reactants.
No specific energy data was available for radiation crosslinking, so an estimate was made based on reference data.

For the environmental impact, the use of green electricity was calculated taking into account the residual electricity mix for the remaining electricity.

While the pipes are manufactured in Germany, they can be used anywhere in the world. However, the focus is on Europe.

Recycling at the end of life depends on the place of use. A European scenario at the end of life was therefore assumed for the assessment.

3.4 Cut-off criteria

In this EPD, all known inputs and outputs were included in the assessment. Due to the very low relevance, individual processes or materials for which no data was available were not taken into account:

- internal transport in the plants
- packaging in which the packaging material is delivered
- production of reusable packaging
- energy requirement for sorting in EoL scenario 1
- utilisation of the used lubricant

They each account for less than 1% of the environmental impact of the overall analysis.

3.5 Background data

Only underlying data from the Sphera *Managed LCA Content* database (version 2024.2, formerly GaBi database) was applied for the LCA. The modelling was carried out using the *LCA for Experts* software from Sphera (version 10.9.0.31, formerly GaBi).

3.6 Data quality

The specific foreground data for the production of 'RAUTITAN stabil' comes from REHAU Industries SE & Co. KG. The geographical, technical and temporal representativeness is rated as very good. Overall, well over 80% of the specific data is rated as good to very good. Specific foreground data of lower quality is available for less than 1% by weight of the pipes.

The underlying data from the *Managed LCA Content* database, which together makes up at least 80% of the core indicators of the impact assessment, is on average well representative (geographically, technically, temporally).

3.7 Period under review

The specific data for the production of 'RAUTITAN stabil' was collected for the production year 2022. Only the natural gas consumption refers to the production year 2021 due to the more detailed data available.

3.8 Geographic Representativeness

Land or region, in which the declared product system is manufactured, used or handled at the end of the product´s lifespan: Germany

3.9 Allocation

No co-products are created during manufacture (modules A1-A3) of the pipes. Therefore, no co-product allocation was necessary for foreground processes.

Material and energy data was available separately for each product. A differentiation from other products manufactured in the plant was therefore already given by the data collection and consequently no allocation was necessary.

Recycling and/or thermal utilisation of packaging materials, production and assembly waste (modules A1-A3 and A5): all process steps are considered until the waste loses its waste status. No benefits are recognised for energy and material recovered during the energy and material recycling of packaging materials and production waste (modules A1-A3), but the energy provided and the processed material are deducted. Benefits are recognised in module D for energy recovered from the energy recovery of packaging materials and assembly waste (module A5).

Benefits and burdens from the recycling and/or energy recovery of the dismantled product (modules C3 and C3/1): all process steps are considered until the waste loses its waste status.

In the case of energy recovery from the dismantled pipe in module C3, recovered energy (thermal and electrical energy) is taken into account as a benefit in module D.

If the dismantled pipe is recycled, the processing in module C3/1 produces PE and aluminium regrind with an economic value (end-of-waste status). The PE regrind consists mainly of thermoset crosslinked polyethylene. Mechanical recycling is therefore not possible. PE regrind cannot replace virgin material. No advantages are taken into account in module D. However, PE regrind can be used as a filler in other products.

The aluminium regrind must be melted down into a casting ingot before being reused, so that this processing step (point of substitution of virgin material) is taken into account in module D/1. The loss of quality due to recycling compared to new aluminium is represented by a substitution factor of 0.7. The substitutable new aluminium product is taken into account as an advantage in module D/1, taking into account the substitution factor.

3.10 Comparability

Basically, a comparison or an evaluation of EPD data is only possible if all the data sets to be compared were created according to *EN 15804* and the building context, respectively the product-specific characteristics of performance, are taken into account. Underlying database: Managed LCA Content from Sphera (version 2024.2, formerly GaBi database)

4. LCA: Scenarios and additional technical information

Characteristic product properties of biogenic carbon

The biogenic carbon content quantifies the amount of biogenic carbon in a construction product that leaves the factory gate and must be stated separately for the product and the associated packaging (packaging weight: 0.17 kg).

Biogenic carbon content at the factory gate

Name	Value	Unit
Biogenic carbon in the product	0	kg C / kg pipe
Biogenic carbon in the associated packaging	0,42	kg C / kg packaging

Note: 1 kg of biogenic carbon is equivalent to 44/12 kg of CO_2.

The following technical information forms the basis for the declared modules or can be used for the development of specific scenarios in the context of a building assessment if modules are not declared (MND).

Transport to the construction site (A4)

Name	Value	Unit
Transport to the dealer by truck (32 t)	800	km
Transport to the construction site by transporter (7.5 t)	30	km

Installation in the building (A5)

Name	Value	Unit
Auxiliary cement	0.0564	kg
Water consumption	0.018	m^3
Electricity consumption	0.062	kWh
Material loss	0.01	kg

End-of-Life (C1--C4)

Name	Value	Unit
Scenario 0: 100% thermal utilisation	0,99	kg
Scenario 1: 100% recycling	0,99	kg
Scenario 2: 100% landfill	0,99	kg

Reuse, recovery and recycling potential (D), relevant scenario information

The advantages and burdens of subsequent utilisation are shown in the following table. Please refer to section 3.9 for further information.

Name	Value	Unit
Scenario 0: Advantages		
Electrical energy (9.90E01 kg of dismantled pipe is thermally utilised)	4,76E +00	MJ
Thermal energy (9.90E01 kg of dismantled pipe is thermally utilised)	8,52E +00	MJ
Electrical energy (1.00E02 kg of pipe waste during installation and 1.66E01 kg of product packaging are thermally utilised)	2,34E-01	MJ
Thermal energy (1.00E02 kg of pipe waste during installation and 1.66E01 kg of product packaging are thermally utilised)	4,22E-01	MJ
Scenario 1: Advantages		
Cast aluminium block (2.42E01 kg with substitution factor 0.7)	1,70E-01	kg
Electrical energy (4.95E02 kg of scrap from processing of recycled pipe is thermally utilised)	2,38E-01	MJ
Thermal energy (4.95E02 kg of scrap from processing of recycled pipe is thermally utilised)	4,26E-01	MJ
Electrical energy (1.00E02 kg of pipe waste during installation and 1.66E01 kg of product packaging are thermally utilised)	2,34E-01	MJ
Thermal energy (1.00E02 kg of pipe waste during installation and 1.66E01 kg of product packaging are thermally utilised)	4,22E-01	MJ
Scenario 1: Loads		
Melting aluminium regrind into cast ingots	2,47E-01	kg
Scenario 2: Advantages		
Electrical energy (1.00E02 kg of pipe waste during installation and 1.66E01 kg of product packaging are thermally utilised)	2,34E-01	MJ
Thermal energy (1.00E02 kg of pipe waste during installation and 1.66E01 kg of product packaging are thermally utilised)	4,22E-01	MJ

5. LCA: Results

The results of the Life Cycle Assessment and the impact assessment for the 'RAUTITAN stabil' pipe analysed are listed in detail below.

EoL scenario 0 (100% thermal utilisation) comprises modules C1, C2, C3, C4 and D.

EoL scenario 1 (100% material utilisation) comprises modules C1, C2/1, C3/1, C4/1 and D/1.

EoL scenario 2 (100% landfill) comprises modules C1, C2/2, C3/2, C4/2 and D/2.

DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LCA; MND = MODULE OR INDICATOR NOT DECLARED; MNR = MODULE NOT RELEVANT)

Product stage			Construction process stage		Use stage							End of life stage				Benefits and loads beyond the system boundaries
Raw material supply	Transport	Manufacturing	Transport from the gate to the site	Assembly	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	X	X	MND	MND	MNR	MNR	MNR	MND	MND	X	X	X	X	X

RESULTS OF THE LCA - ENVIRONMENTAL IMPACT according to EN 15804+A2: 1 kg RAUTITAN stabil

Parameter	Unit	A1-A3	A4	A5	C1	C2	C2/1	C2/2	C3	C3/1	C3/2	C4	C4/1	C4/2	D	D/1	D/2
GWP-total	kg CO_2 eq	4.48E+00	3.8E-02	2.37E-01	4.04E-02	7.24E-03	2.05E-02	7.24E-03	2.28E+00	3.8E-01	0	0	0	2.54E-02	-1.03E+00	-1.42E+00	-4.83E-02
GWP-fossil	kg CO_2 eq	4.58E+00	3.74E-02	1.28E-01	4.04E-02	7.12E-03	2.02E-02	7.12E-03	2.28E+00	3.8E-01	0	0	0	2.53E-02	-1.02E+00	-1.41E+00	-4.81E-02
GWP-biogenic	kg CO_2 eq	-1.09E-01	0	1.09E-01	9.8E-06	0	0	0	4.64E-05	8.09E-04	0	0	0	0	-4.4E-03	-4.11E-03	-2.06E-04
GWP-luluc	kg CO_2 eq	3.74E-03	6.31E-04	4.59E-05	4.14E-06	1.14E-04	3.24E-04	1.14E-04	6.29E-05	3.08E-05	0	0	0	1.02E-04	-9.26E-05	-2.61E-04	-4.35E-06
ODP	kg CFC11 eq	1.38E-11	5.53E-15	1.33E-13	2.29E-15	1E-15	2.84E-15	1E-15	1.88E-13	3E-14	0	0	0	8.1E-14	-9.04E-12	-1.19E-12	-4.23E-13
AP	mol H^+ eq	1.74E-02	8.21E-05	1.83E-04	5.42E-05	1.09E-05	3.1E-05	1.09E-05	2.79E-04	3.71E-04	0	0	0	1.56E-04	-1.07E-03	-7.34E-03	-5E-05
EP-freshwater	kg P eq	6.97E-06	1.6E-07	1.14E-05	1.07E-08	2.91E-08	8.23E-08	2.91E-08	1.09E-07	1.01E-06	0	0	0	1.22E-05	-1.69E-06	-4.96E-07	-7.93E-08
EP-marine	kg N eq	3.75E-03	3.39E-05	1.01E-04	1.47E-05	4.1E-06	1.16E-05	4.1E-06	7.09E-05	1.04E-04	0	0	0	3.47E-05	-3.26E-04	-1.43E-03	-1.53E-05
EP-terrestrial	mol N eq	4.15E-02	3.9E-04	6.6E-04	1.6E-04	4.81E-05	1.36E-04	4.81E-05	1.32E-03	1.12E-03	0	0	0	3.81E-04	-3.5E-03	-1.57E-02	-1.65E-04
POCP	kg NMVOC eq	1.23E-02	7.88E-05	1.64E-04	4.17E-05	1.06E-05	3.01E-05	1.06E-05	2.04E-04	2.85E-04	0	0	0	1.1E-04	-9.24E-04	-4.22E-03	-4.34E-05
ADPE	kg Sb eq	5.63E-07	3.27E-09	1.89E-09	5.03E-10	5.93E-10	1.68E-09	5.93E-10	2.36E-09	3.46E-09	0	0	0	1.67E-09	-8.81E-08	-8.39E-08	-4.13E-09
ADPF	MJ	9.2E+01	4.95E-01	8.54E-01	5.64E-01	8.97E-02	2.54E-01	8.97E-02	4.29E-01	3.73E+00	0	0	0	4.12E-01	-1.82E+01	-1.67E+01	-8.56E-01
WDP	m^3 world eq deprived	1.26E+00	5.82E-04	2.46E-02	3.21E-03	1.05E-04	2.99E-04	1.05E-04	2.41E-01	3.34E-02	0	0	0	3.21E-03	-1.09E-01	-5.99E-01	-5.1E-03

GWP = Global warming potential; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential of land and water; EP = Eutrophication potential; POCP = Formation potential of tropospheric ozone photochemical oxidants; ADPE = Abiotic depletion potential for non-fossil resources; ADPF = Abiotic depletion potential for fossil resources; WDP = Water (user) deprivation potential)

RESULTS OF THE LCA - INDICATORS TO DESCRIBE RESOURCE USE according to EN 15804+A2: 1 kg RAUTITAN stabil

Parameter	Unit	A1-A3	A4	A5	C1	C2	C2/1	C2/2	C3	C3/1	C3/2	C4	C4/1	C4/2	D	D/1	D/2
PERE	MJ	2.55E+01	4.26E-02	1.24E+00	2.63E-02	7.73E-03	2.19E-02	7.73E-03	1.2E-01	1.82E-01	0	0	0	6.36E-02	-6.04E+00	-9.91E+00	-2.83E-01
PERM	MJ	2.43E+00	0	-2.43E+00	0	0	0	0	0	0	0	0	0	0	0	0	0
PERT	MJ	2.8E+01	4.26E-02	-1.19E+00	2.63E-02	7.73E-03	2.19E-02	7.73E-03	1.2E-01	1.82E-01	0	0	0	6.36E-02	-6.04E+00	-9.91E+00	-2.83E-01
PENRE	MJ	9.28E+01	4.95E-01	1.34E+00	5.64E-01	8.97E-02	2.54E-01	8.97E-02	3.24E+01	5.32E+00	0	0	0	4.12E-01	-1.82E+01	-1.67E+01	-8.56E-01
PENRM	MJ	3.24E+01	0	-4.85E-01	0	0	0	0	-3.19E+01	-3.19E+01	0	0	0	0	0	0	0

PENRT	MJ	1.25E +02	4.95E-01	8.54E-01	5.64E-01	8.97E-02	2.54E-01	8.97E-02	4.29E-01	-2.66E +01	0	0	0	4.12E-01	-1.82E +01	-1.67E +01	-8.56E-01
SM	kg	7.77E-02	0	0	0	0	0	0	0	0	0	0	0	0	0	9.37E-01	0
RSF	MJ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NRSF	MJ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FW	m^3	4.87E-02	4.75E-05	6.08E-04	7.86E-05	8.61E-06	2.44E-05	8.61E-06	5.65E-03	8.06E-04	0	0	0	9.62E-05	-4.62E-03	-2.2E-02	-2.16E-04

PERE = Use of renewable primary energy excluding renewable primary energy resources used as raw materials; PERM = Use of renewable primary energy resources used as raw materials; PERT = Total use of renewable primary energy resources; PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials; PENRM = Use of non-renewable primary energy resources used as raw materials; PENRT = Total use of non-renewable primary energy resources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Use of net fresh water

RESULTS OF THE LCA – WASTE CATEGORIES AND OUTPUT FLOWS according to EN 15804+A2:
1 kg RAUTITAN stabil

Parameter	Unit	A1-A3	A4	A5	C1	C2	C2/1	C2/2	C3	C3/1	C3/2	C4	C4/1	C4/2	D	D/1	D/2
HWD	kg	2.93E-08	1.89E-11	2.37E-10	6.43E-11	3.43E-12	9.72E-12	3.43E-12	2.43E-10	4.41E-10	0	0	0	1.02E-10	-1.22E-08	-2.24E-09	-5.71E-10
NHWD	kg	1.25E +00	8.08E-05	2.24E-02	1.55E-04	1.46E-05	4.15E-05	1.46E-05	1.28E-01	8.85E-03	0	0	0	9.87E-01	-9.45E-03	-6.49E-01	-4.44E-04
RWD	kg	1.88E-03	9.01E-07	6.32E-05	4.59E-05	1.63E-07	4.63E-07	1.63E-07	2.17E-05	3.02E-04	0	0	0	5.63E-06	-1.33E-03	-8.35E-04	-6.23E-05
CRU	kg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MFR	kg	1.13E-01	0	0	0	0	0	0	0	9.4E-01	0	0	0	0	0	0	0
MER	kg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EEE	MJ	1.12E-01	0	2.34E-01	0	0	0	0	4.76E +00	2.38E-01	0	0	0	0	0	0	0
EET	MJ	2.57E-01	0	4.22E-01	0	0	0	0	8.52E +00	4.26E-01	0	0	0	0	0	0	0

HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported electrical energy; EET = Exported thermal energy

RESULTS OF THE LCA – additional impact categories according to EN 15804+A2-optional:
1 kg RAUTITAN stabil

Parameter	Unit	A1-A3	A4	A5	C1	C2	C2/1	C2/2	C3	C3/1	C3/2	C4	C4/1	C4/2	D	D/1	D/2
PM	Disease incidence	3.01E-07	7.26E-10	1.81E-09	5.03E-10	1.14E-10	3.23E-10	1.14E-10	2.49E-09	3.44E-09	0	0	0	1.67E-09	-8.74E-09	-1.39E-07	-4.1E-10
IR	kBq U235 eq	2.08E-01	1.31E-04	6.98E-03	4.22E-03	2.37E-05	6.71E-05	2.37E-05	3.41E-03	2.79E-02	0	0	0	7.61E-04	-2.19E-01	-8.61E-02	-1.02E-02
ETP-fw	CTUe	4.22E +01	3.67E-01	5.96E-01	7.9E-02	6.66E-02	1.89E-01	6.66E-02	2.14E-01	5.63E-01	0	0	0	8.2E-01	-2.55E +00	-4.84E +00	-1.2E-01
HTP-c	CTUh	4.29E-09	7.42E-12	6.14E-11	3.17E-12	1.34E-12	3.81E-12	1.34E-12	1.75E-11	2.6E-11	0	0	0	1.23E-11	-2.08E-10	-1.9E-09	-9.76E-12
HTP-nc	CTUh	5.05E-08	3.33E-10	5.73E-09	1.22E-10	6.03E-11	1.71E-10	6.03E-11	2E-10	1.24E-09	0	0	0	2.7E-10	-4.9E-09	-1.28E-08	-2.3E-10
SQP	SQP	1.34E +01	2.43E-01	1.2E-01	4.82E-02	4.41E-02	1.25E-01	4.41E-02	1.49E-01	3.25E-01	0	0	0	7.56E-02	-3.55E +00	-6.79E-01	-1.66E-01

PM = Potential incidence of disease due to PM emissions; IR = Potential Human exposure efficiency relative to U235; ETP-fw = Potential comparative Toxic Unit for ecosystems; HTP-c = Potential comparative Toxic Unit for humans (cancerogenic); HTP-nc = Potential comparative Toxic Unit for humans (not cancerogenic); SQP = Potential soil quality index

Disclaimer 1 – applies for the indicator 'Potential effect of human exposure to U235'.

This impact category deals mainly with the possible effect of low-dose ionising radiation on human health in the nuclear fuel cycle. It does not take into account effects attributable to possible nuclear accidents and occupational exposure, or to the disposal of radioactive waste in underground facilities. The potential ionising radiation emitted by soil, radon and some building materials is also not measured by this indicator.

Disclaimer 2 – applies to the indicators: 'Abiotic depletion potential for non-fossil resources', 'Abiotic depletion potential for fossil fuels', 'Water depletion potential (users)', 'Potential toxicity comparison unit for ecosystems', 'Potential toxicity comparison unit for humans (carcinogenic)', 'Potential toxicity comparison unit for humans (non-carcinogenic)', 'Potential soil quality index'.

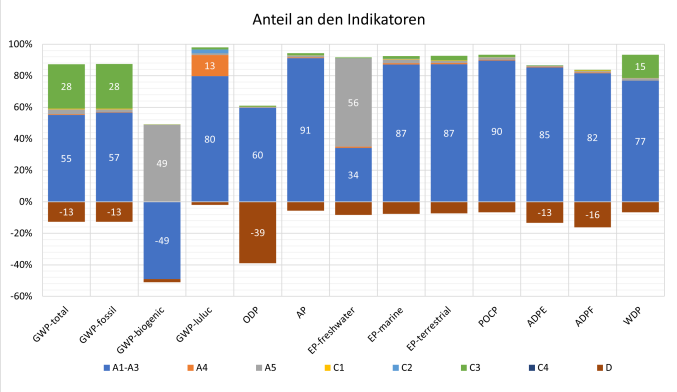
The results of these environmental impact indicators must be used with caution, as the uncertainties of these results are high or there is limited experience with the indicator.

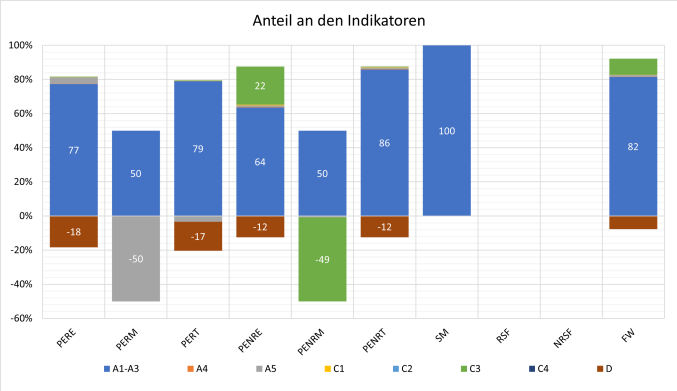
6. LCA: Interpretation

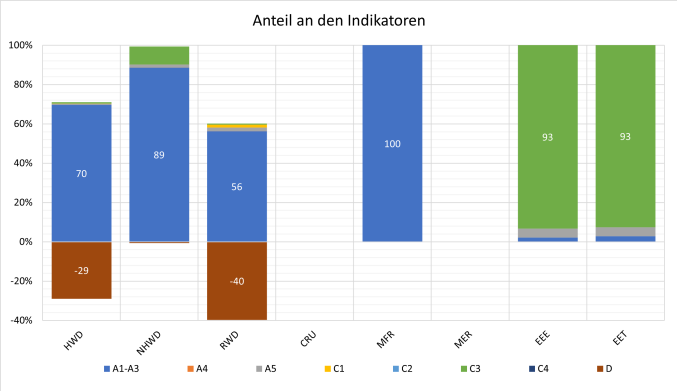
In the following section, the LCA results for **scenario 0 (100% thermal utilisation)** are presented graphically and interpreted. The majority of the indicators on environmental impact and resource consumption are dominated by the production phase (modules A1-A3) in scenario 0. Waste treatment (Module C3) also plays a significant role in the indicators. Furthermore, the effects within the system boundaries can be partially compensated by utilisation potentials outside the system boundaries (module D). Within modules A1-A3, the production of aluminium and polyethylene dominates the indicators. The thermal utilisation of the pipe is decisive for the environmental impacts in module C3. The advantages in module D result from

the substitution of electrical and thermal energy.

Antei an den Indikatoren = Share of the indicators



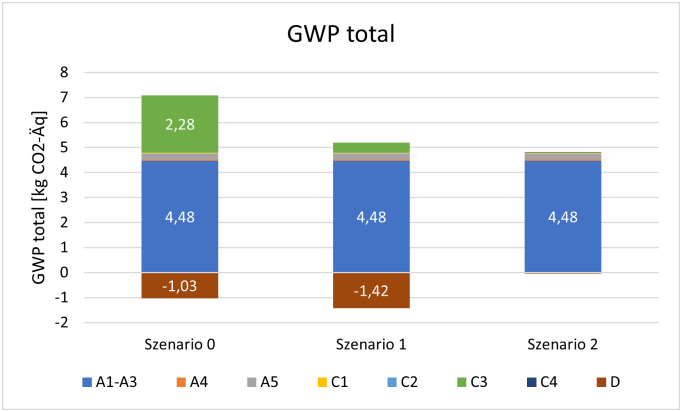




Scenario 1 – 100% material recycling:
The influence of module C3 on the indicators decreases. The benefits from module D increase somewhat, as secondary materials from material recycling can be accessed outside the system boundaries.

Scenario 3 – 100% landfill:
The influence of module C3 is completely reduced. Instead, disposal (module C4) plays a limited role.

The following figure shows the LCA results for the 'GWP-total' indicator (global warming potential). The diagram shows the absolute values (kg CO2 equivalents).



In scenario 0 (100% thermal utilisation), 'GWP-total' is dominated by the production phase (modules A1-A3) and waste treatment (module C3). The impacts within the system boundaries can be partially compensated by utilisation potentials outside the system boundaries (module D).

In scenario 1 (100% material recycling), the influence of module C3 on 'GWP-total' decreases. The benefits from module D increase. The production phase is dominant.

In scenario 2 (100% landfill), the influence of module C3 is completely reduced. Instead, disposal (module C4) plays a limited role. The production phase is dominant.

7. Requisite evidence

'RAUTITAN stabil' fulfils the requirements of the *EN ISO 21003* standard and the corresponding certificates are available from REHAU on request.

8. References

Standards

EN 15804
EN 15804:2012+A2:2019+AC:2021, Sustainability of construction works – Environmental product declarations – Basic rules for the product category construction products

ISO 14025
EN ISO 14025:2011, Environmental labels and declarations – Type III environmental declarations – Principles and procedures

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Multilayer piping systems for hot and cold water installations inside buildings – Part 2: Pipes

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Further literature

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Federal Ministry of Justice (2001): Regulation on the European List of Waste. URL: https://www.gesetzeiminternet.de/avv/AVV.pdf (last accessed 20 December 2024)

Software/database

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Managed LCA Content (formerly GaBi- database), version 2024.2, Chicago (USA): Sphera Solutions, Inc. (last accessed on 20 December 2024)

Software
LCA for Experts (formerly GaBi), version 10.9.0.31, Chicago (USA): Sphera Solutions, Inc. (last accessed on 20 December 2024)

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